NPRDC Papers from the Second International Symposium on Human Factors in Organizational Design and Management

Bela Feher, *Editor*

Contributors

Steve L. Dockstader
Linda M. Doherty
Mark F. Levine
Carol Ann Robinson
John P. Sheposh
Joyce Shettel-Neuber
Marie D. Thomas

Approved by
Richard C. Sorenson

Released by
B. E. Bacon
Captain, U. S. Navy
Commanding Officer
and
James S. McMichael
Technical Director

Navy Personnel Research and Development Center
San Diego, California 92152-6800

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution is unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) NPRDC TR 88-7	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION Navy Personnel Research and Development Center 6b. OFFICE SYMBOL (if applicable) Code 41	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (City, State and ZIP Code) San Diego, CA 92152-6800	7b. ADDRESS (City, State and ZIP Code)
8a. NAME OF FUNDING/SPONSORING ORGANIZATION 8b. OFFICE SYMBOL (if applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State and ZIP Code)	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT NO.

11. TITLE (include Security Classification)
NPRDC Papers from the Second International Symposium on Human Factors in Organizational Design and Management.

12. PERSONAL AUTHOR(S) Feher, B., Dockstader, S.L., Doherty, L.M., Levine, M.F., Robinson, C.A., Sheposh, J.P., Shettel-Neuber, J., Thomas, M.D.

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Final	FROM 1986 TO 1987	February 1988	37

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Computerized training aids, portable training aids, CHIP, automated surveys, CENSUS, quality control, statistical process control, organization change,
05	01		

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

Five papers by researchers from the Navy Personnel Research and Development Center are reprinted from the proceedings of the Second International Symposium on Human Factors in Organizational Design and Management. They represent a broad range of research, from exploration of new technologies to their implementation and effects. The topics include development and evaluation of a hand-held computerized training aid, testing of an automated survey technology, assessment of the impact of total quality control programs on job and organization design, methods of evaluating the implementation of organizational change, and a case study of organizational learning in relation to current theory.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT	21. ABSTRACT SECURITY CLASSIFICATION	
[X] UNCLASSIFIED/UNLIMITED [ ] SAME AS RPT [ ] DTIC USERS	UNCLASSIFIED	
22a. NAME OF RESPONSIBLE INDIVIDUAL Bela Feher	22b. TELEPHONE (include Area Code) (619) 553-9228	22c. OFFICE SYMBOL Code 41

DD FORM 1473, 84 JAN

83 APR EDITION MAY BE USED UNTIL EXHAUSTED
ALL OTHER EDITIONS ARE OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

Block 18. (Continued) job design, change theory, change evaluation, organizational learning, sociotechnical systems

FOREWORD

The Second International Symposium on Human Factors in Organizational Design and Management was held in Vancouver, British Columbia, Canada, during 19-21 August 1986. It was co-sponsored by the Organizational Design and Management Technical Group, its parent organization, the Human Factors Society (U.S.), the Human Factors Association of Canada, the International Ergonomics Association, and the Japan Ergonomics Research Society. The symposium chair was Hal W. Hendrick, and the technical program chair was Ogden Brown, Jr.

Papers from the conference were published in the symposium proceedings, entitled *Human Factors in Organizational Design and Management - II*, published in Amsterdam by Elsevier Science Publishers (North-Holland) in 1986. Papers by NPRDC researchers are reprinted here to make them more accessible to a wider audience.

B. E. BACON
Captain, U. S. Navy
Commanding Officer

JAMES S. McMICHAEL
Technical Director

SUMMARY

The Second International Symposium on Human Factors in Organizational Design and Management was held to foster communication about theories, methods, and research findings in the newly emerging interdisciplinary field of macroergonomics. Macroergonomics is historically grounded in human factors, which, according to the International Ergonomics Association, concerns the relations between man and his occupation, equipment, and environment in the widest sense, including work, play, leisure, home, and travel situations. Macroergonomics derives from human factors theories and methods, but focuses on organizational units and subsystems rather than individuals. Brown and Hendrick, editors of the proceedings of the Second International Symposium, claim that "new technology, a changing demographic composition, changing values and attitudes of workforces, and a renewed emphasis on both productivity and the quality of work life have created a need for a true macroergonomic systems approach to the design of organizational and managerial systems."

The papers reprinted here from the proceedings represent five varied elements and applications within the new macroergonomic perspective. They also represent five distinct thrusts occurring within a single organization, the Navy Personnel Research and Development Center. In another sense, they may be taken as five responses to the varied needs of the larger system (the Navy) in which this research center is embedded. The order of presentation moves roughly from the exploration of new technologies to their implementation and effects.

Robinson describes the development and evaluation of a computerized training aid that is responsive to individual differences in ability and allows self-pacing. It also offers a high degree of flexibility for course authors. She presents a multi-dimensional plan for assessing the effectiveness of the device.

Doherty and Thomas show how new technology in computing and communications can be applied to information gathering and analysis undertaken for attitudinal and policy evaluation surveys. Their comparison of results from a paper-and-pencil survey and from an automated version of the same survey reveals differing attitudes and expectations among the respondents. The authors raise new research issues related to the capabilities and characteristics of automated surveys.

Dockstader assesses the impact of total quality control programs on job and organization design in American companies. His assessment is that workers and managers are affected differently by a shift to process control. In this light, managers may be the real stumbling block to change, due to their lack of appreciation of the need for systemic change and unwillingness to reexamine their assumptions and managerial approach.

Sheposh and Shettel-Neuber present a multi-method approach to understand the implementation of a quality program in a Navy organization. They integrate two seemingly opposed approaches to evaluating change--the theory-driven approach and grounded theory-building. The former applies a general, theory-derived framework to the specific organizational situation; the latter builds a model based on observations of the specific case.

Levine and Feher describe how organizational learning continued to take place following an organization redesign project. The redesign project provided a new organizational paradigm, which was subsequently reflected in management actions showing both cognitive and behavioral learning at a variety of levels. Empirical findings were compared to the current concept of organizations as interpretive information processing systems.

CONTENTS

INTRODUCTION

A variety of forces have converged to produce the new interdisciplinary field of macroergonomics. This field has historical roots in the science of human factors. As the scope of systems under study has grown and the nature of the component elements (workers, management, organization, and technology) changed, practitioners have had to adapt the human factors technologies. Brown and Hendrick (1986)[1] claim that "new technology, a changing demographic composition, changing values and attitudes of workforces, and a renewed emphasis on both productivity and the quality of work life have created a need for a true macroergonomic systems approach to the design of organizational and managerial systems." These challenging new problems have required extending traditional theories and methods or developing new ones.

The new field of macroergonomics has needed a vehicle by which practitioners could exchange information about new concepts and methods. This need was filled to some extent by the initiation in 1984 of an international symposium on human factors in organizational design and management. The Second International Symposium took place in Vancouver, British Columbia, in 1986. Five papers were submitted to the symposium by members of the Navy Personnel Research and Development Center. These papers reflect the variety and breadth of both the organization in which the authors work and the field of macroergonomics. They represent five distinct thrusts, each addressing needs of the larger Navy system. They all deal with the fact that advancements in organizational effectiveness require more than just the introduction of new concepts or technologies. Mutual adaptation of the concepts/technologies and the organizations to which they are applied is required to optimize their fit. These papers reflect considerations of design and process before, during, and after the introduction of change.

BACKGROUND

The Research Setting

The Navy Personnel Research and Development Center (NPRDC) is the principal Navy activity for conducting research in the areas of manpower/personnel, training, and human factors.[2]

Training

The Training Technology Department assesses new instructional technologies and develops and evaluates techniques for course design, instructional delivery, and training management for both individual and team training. It also designs, evaluates, and validates training systems to ensure that they are compatible with operational and personnel subsystems in the Navy. The Training Systems Department adapts existing and emerging training and simulation technologies to shipboard, shore-based, air, Marine Corps, and Navy civilian workforce training requirements.

---

1 Brown, O., Jr., and Hendrick, H. W. (Eds.). (1986). "Preface" to Human factors in organizational design and management - II. Amsterdam: Elsevier Science Publishers (North-Holland).

2 This description of the structure of NPRDC and its research programs is adapted from the summary statements given in the Center's 1986 Project Profiles (San Diego: Navy Personnel Research and Development Center).

Manpower/Personnel

The Manpower Systems Department develops techniques and systems for determining manpower requirements, allocating manpower resources, and controlling personnel inventories. It also develops comprehensive manpower planning techniques for rapid response to fluctuations in personnel resources and commitments. The Personnel Systems Department develops methods and procedures to improve recruitment, assessment, selection, classification, satisfaction, and retirement of personnel. The Testing Systems Department develops adaptive assessment systems to replace existing instruments [e.g., the Armed Services Vocational Aptitude Battery (ASVAB)] and evaluates new computer-based procedures to improve measurement of Navy personnel.

Human Factors

The Human Factors Department conducts R&D to extend knowledge of human processes underlying human-machine functions to optimize the design, development, operation, and maintenance of Navy human-machine systems. It also conducts R&D addressing organizational effectiveness and performance of military and civilian personnel. Individual and organizational processes are assessed to enhance motivation and performance. Strategies are developed and applied to improve quality and productivity of Navy organizations.

The Authors

The following are short biographical sketches of the authors.

Bela Feher (Ph.D., social psychology, Wayne State University, 1970) has primary interests in organizational assessment, design, and change. He has applied systems theories to shipboard organization, command and control, and repair system design and change. His current work involves studies of command structure, information flow, and distributed decision making during simulated naval combat.

Steve L. Dockstader (Ph.D., experimental psychology, Denver University, 1973). The focus of his research has been on the design, test, and evaluation of productivity improvement systems for Navy maintenance and repair organizations. Most recently, these efforts have been concerned with the application of statistical methods to improve quality and productivity.

Linda M. Doherty (Ph.D., quantitative psychology, University of Southern California, 1973) is in charge of Project CENSUS, an automated survey system. She is currently interested in applying automated survey technology to organization assessment and program evaluation.

Mark F. Levine (Ph.D., sociotechnical systems, University of California at Los Angeles, 1979) is professor of management at California State University, Chico. His current research interests are sociotechnical system design and measurement of quality of working life.

Carol Ann Robinson (Ph.D., experimental psychology, University of California, San Diego, 1979) has applied her background in the area of cognitive psychology to the development and testing of innovative training technologies. Recently, she was a member of the Computerized Hand-held Instructional Prototype (CHIP) working group, a joint-service effort.

John P. Sheposh (Ph.D., social psychology, Wayne State University, 1968) is a professor of psychology at San Diego State University. His research interests include conflict resolution and organizational change. The research reported in this paper forms part of a larger program concerned with the assessment of organizational change.

Joyce Shettel-Neuber (Ph.D., environmental psychology, University of Arizona, 1986) is involved in a research effort evaluating the effects of a variety of organizational changes on the individual and work groups in public sector organizations. In addition to program evaluation, her interests include environmental assessment, with a particular emphasis on zoos and museums.

Marie D. Thomas (Ph.D., psychometrics, Fordham University, 1981) is an assistant professor of psychology at the College of Mount St. Vincent in New York City. She worked on Project CENSUS, an automated survey system at NPRDC, as a Summer Faculty Research Fellow co-sponsored by the U.S. Navy and the American Society for Engineering Education.

PAPERS

The order of presentation of the five papers roughly reflects the movement from exploration of new technologies to their implementation and effects. The papers present conceptual and methodological issues relevant at each stage of the process.

Human Factors in Organizational Design and Management - II
O. Brown, Jr. and H.W. Hendrick (Editors)
Elsevier Science Publishers B.V. (North-Holland), 1986

A Hand-Held Training Aid In A Military Environment: Description and Proposed Evaluation[1]

Carol Ann Robinson Ph.D.

Navy Personnel Research and Development Center
San Diego, CA 92152

ABSTRACT

This paper describes a portable, low-cost, computerized, hand-held training aid that can supplement classroom training and provide off-site training and practice opportunities in a variety of Army, Air Force, and Navy technical specialties. The engineering design, software and courseware incorporated the latest in electronic, human factors, and training technologies. Software and courseware were designed to provide intrinsic motivation and enhance the effectiveness of training. The evaluation plan that describes the research questions and associated measures is also presented.

BACKGROUND

Recent advances in semiconductor technology have made possible the development of low-cost, hand-held, computerized training devices. These devices offer many of the features of larger, traditional, computer tutoring systems, as well as the ability to bring military training to nontraditional learning environments, such as study halls or barracks or in the field.

The U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) commissioned the development of a small, low-cost, battery-operated, hand-held computer with a one-line video display screen and voice/sound simulation capability that can be used with a booklet for introducing new military terminology. The prototype device, called TUTOR, responds to differing knowledge and motivational levels and rates of learning. It provides frequent corrective feedback and a variety of instructional routines that include gaming features to provide intrinsic motivation and enhance the effectiveness of training.

Field tests showed that students used the TUTOR widely and, with equivalent amounts of training time, they retained material presented by TUTOR more effectively than material presented by conventional media (Wisher, 1985).

The success of TUTOR encouraged wider applications for this device. A joint military service effort to develop a training aid that can be used by all branches of the U.S. military has produced the computerized hand-held instructional prototype or CHIP. CHIP is not limited to job-related vocabulary training but can be used to also teach job-related procedural tasks. This upgraded device includes expanded gaming features, record-keeping, progress-checking, and courseware authoring capabilities.

DESCRIPTION

Like TUTOR, the CHIP technology is designed around a familiar and useful medium--the book. This book or booklet contains graphics, instructional text, and test questions that are used with CHIP's prompts and feedback. Separate plug-in cartridges and different accompanying booklets will enable CHIP to supplement classroom training for various technical training schools or to provide remedial training, on-the-job refresher, or sustainment training.

Hardware Description

CHIP (Figure 1) is about the shape and size of a three-ring binder and weighs, including batteries but excluding the booklet, about 5 pounds.

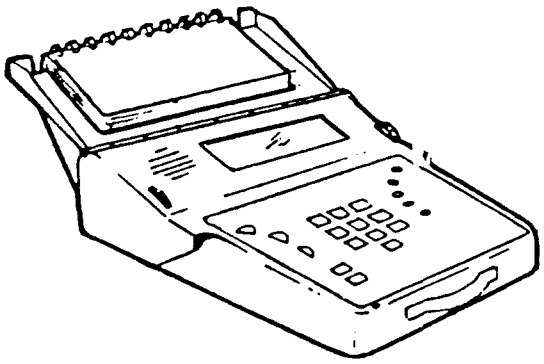

Figure 1. CHIP.

CHIP was designed to be easy to carry, set up, and operate under a variety of conditions. Its case, display, keyboard, and audio and video features incorporate the latest in human factors technology. The lid snaps open and folds back to support the booklet, which places the booklet in the same visual plane as the display screen. The pages of the booklet flip up over the top rather than to the side, minimizing the likelihood of the wind accidently turning the pages when CHIP is used in a field environment.

The audiovisual area slopes up from the keyboard area for an optimum viewing angle of approximately 22 degrees. The speaker and display screen are side by side to make audiovisual outputs emanate from the same general area. A liquid crystal display screen capable of displaying eight 40-character lines allows simultaneous display of several lines of text and arcade type gaming graphics.

The audio and video controls and the most frequently used input keys are arranged so that they can be easily operated by the thumb. This feature allows for the student to devote more attention to the visual information on the screen and in the booklet and less attention to finding the right keys.

Keys A,B,C,D, and E (Figure 2), which are used extensively in responding to multiple-choice questions, are laid out in an arc on the right side. An embossed ridge

bisecting the key C, as well as an embossed dimple, help the students find the center key with their thumb. The five YES, NO, GO, ERASE, and SAY special function keys are on the left side with the Go key identified by an embossed dimple and ridge. The less frequently used numerical keys are arranged in a 3x3x1 pattern in the center of CHIP.

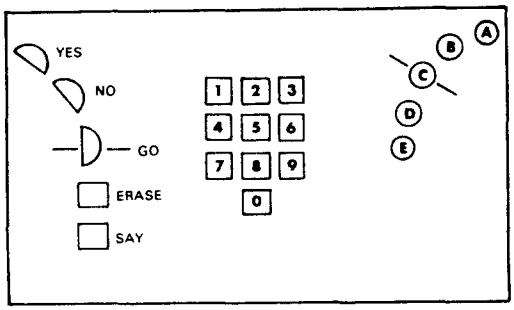

Figure 2. Keyboard Layout.

The CHIP's main printed circuit board contains a microcontroller, memory, logic, speech, and driver circuits. The removable courseware cartridge contains a smaller printed circuit board, which is enclosed in a plastic housing for protection.

CHIP is powered by four or eight removable D-size batteries. With eight nickel-cadmium batteries, CHIP will operate for about 65 hours without recharging.

Software/Courseware Design

The basic philosophy behind the development of CHIP is that learning will be more likely to occur if it is convenient and interesting. CHIP makes learning more convenient than conventional methods by being easily transportable. CHIP makes learning more interesting by including several instructional routines based on training principles from cognitive psychology and video gaming techniques to improve intrinsic motivation and training effectiveness.

Four independent but mutually supportive instructional routines that can be used for any training application were developed. These are:

1. Pregame. This routine has two modes: warmup and explanation. The warmup consists of questions in the booklet. The students respond to each question by pushing the appropriate key on the keyboard. After the students have finished all the questions, voiced feedback tells them the number of correct answers. The explanation mode which follows, consists of tutorial material containing embedded questions with immediate feedback. The pregame does not include any gaming features because they might distract students during the initial explanation process (Malone, 1981).

2. Roll Call. This drill and practice gaming technique requires the students to match a list of ten words with their definitions, or vice versa. Three choices of answers per word or definition continue to cycle on the screen, one at a time, until the student selects an answer. The goal of the game is to create on the screen a formation of 10 soldiers, as at morning muster. For each correct answer selected, CHIP says "Here, Sir" and adds a soldier to the formation on the screen; for each incorrect answer, CHIP responds "Missing"

and displays a blank slot in the formation. If the student scores 100 percent, the CHIP says "All present and accounted for, Sir."

3. Target Practice. This routine may be used to augment vocabulary training or present general multiple-choice or matching questions. Typically, CHIP asks questions about a picture in the booklet. The gaming technique in this exercise features a "friendly" and an "unfriendly" projectile at either end of the screen. Each correct answer selected on CHIP moves the friendly projectile along a trajectory toward a target; an incorrect answer moves the unfriendly trajectory. A new projectile is fired upon each response, its distance depending on the number of correct and incorrect responses to date.

4. Mine Field. This instructional routine reviews and drills in step-by-step procedures. There are two principal modes: A job-step review that displays the steps of a job one at a time in the order they should be performed and a game that provides drills about the sequence in which these steps are performed. The main objective of this game mode is for students to successfully progress through a mine field by correct responses to procedural steps.

The other three routines can also be used to supplement the job-step routine in training procedures. To accommodate individual differences in learning and also to provide challenge to the student, each game has a basic and an advanced level.

Courseware is typically divided into 30 or 40 lesson segments. Each lesson segment uses the routines that are applicable to its subject matter. Students control the order in which they work on lesson segments.

CHIP includes software to keep and retrieve student records including student number, the number of instructional units completed, and student performance data. These records can be uploaded to a desktop microprocessor for detailed analysis by training personnel. An authoring aid allows training personnel to create new instructional bases.

PROPOSED EVALUATION

CHIP will be evaluated in at least five applications. Each service will select the appropriate test environment (e.g., classroom or field) and use (e.g., classroom training or refresher training).

The performance of students trained by CHIP will be compared with that of students trained by conventional methods. The significant research questions and associated measures to be analyzed (listed below) will be adapted as needed to particular test applications:

1. The effectiveness of CHIP for training will be determined by final exam games, learning gains as reflected in the difference in pre- and posttest scores, time-to-completion of course segments, academic setbacks, attrition rates, hands-on tests, and transfer of training.

2. The usage patterns for CHIP will be analyzed by determining the time to complete given segments and the human factors features that affect use (e.g., readability, sound, ease of using booklet, key placement, and so on).

3. Student and instructor attitudes toward CHIP, computer-assisted instruction, traditional instruction, and related factors will be assessed by a questionnaire.

4. The background and ability of the students using CHIP will be determined by an assessment of ASVAB scores, background knowledge, age, and educational history.

5. How usage patterns, attitudes, and student ability and background relate to training effectiveness will be determined.

Human factors and logistical data such as storage and distribution requirements, reliability of devices, and transportability will also be collected.

Evaluation findings from all applications will be integrated and collapsed for the preparation of a cost and training effective analysis (CTEA). Findings will include data on training effectiveness, usage patterns, reliability, availability and maintainability.

Based on TUTOR's evaluation students using CHIP are expected to show better retention of materials. Research suggest that military student attitudes are positive toward computer-aided instruction (Robinson, Tomblin, & Houston, 1981 and Robinson, Smith, & Thode, in preparation). Preliminary results suggest that expanded gaming features result in greater usage, and retention of instructional materials.

[1] The views expressed in this article are those of the author, are not official, and do not necessarily reflect the views of the Navy Department.

REFERENCES

[1] Malone, T.W. Toward a theory of intrinsically motivating instruction. Cognitive Science, 4, (1981) 333-369.

[2] Robinson, C.A., Tomblin, E.A. and Houston, A. Computer-managed instruction in Navy technical training: an attitudinal survey (NPRDC Tech. Rep. 82-19) (Navy Personnel Research and Development Center, San Diego, December 1981).

[3] Robinson, C.A., Smith W.H., and Thode W.F. Microprocessor-based on-site training for passive acoustic analysts: II. Lesson development and evaluation. (Navy Personnel Research and Development Center, San Diego, in preparation).

[4] Wisher, R.A. The development and test of a hand-held computerized training aid. Paper presented at NATO Symposium on Training Technology (Brussels, Belgium, April 1985).

Human Factors in Organizational Design and Management - II
O. Brown, Jr. and H.W. Hendrick (Editors)
Elsevier Science Publishers B.V. (North-Holland), 1986

EFFECTS OF AN AUTOMATED SURVEY SYSTEM UPON RESPONSES[1]

Linda M. Doherty
Navy Personnel Research and Development Center
San Diego, CA 92152-6800

Marie D. Thomas
College of Mount St. Vincent
Riverdale, NY 10471

Recent developments in computer capabilities and communications are enabling quality surveys to be designed, administered and analyzed efficiently and accurately. This paper describes (1) components of one automated survey system, (2) field results comparing computerized and paper and pencil surveys, and (3) future research issues on the effects of automated surveys upon individuals and responses.

INTRODUCTION

Survey research in the past has primarily used computer technology as a tool to statistically analyze questionnaire responses. While this is a necessary function, computers now facilitate surveys to be designed, administered, analyzed and reported efficiently and in a timely manner. Existing computer technology is sufficiently inexpensive so that most computers can communicate with remote terminals to collect and analyze atttitudinal information, and integrate that information with other data bases. Currently, the private sector uses computer capabilities and communications to conduct surveys quickly and efficiently on a broad range of topics that include elections, Nielson television ratings, and consumer product evaluation. The Census bureau is testing one such automated survey system, Computer Assisted Telephone Interviewing (CATI) system, where interviewers interact with a computer to make contact with respondents by telephone, and ask them branching, in-depth questions that are recorded immediately into the computer, updating existing files (Nicholls, 1983).

Besides the obvious speed of conducting surveys on computers, thereby eliminating the traditional paper and pencil instruments themselves, there are several unique aspects to conducting surveys using an automated system that involve and affect the respondent. Questionnaires may now be adapted to individuals, since the computer has the ability to easily and quickly skip blocks of questions and probe issues in depth through extensive branching of questions. Scales could be constructed that would be sensitive to capture differences in individuals' attitudes, and then using the flexibility of the computer, adapt questions and scales to more precisely measure individuals' attitudes. Second, using the computer will decrease errors at all phases of questionnaire design, administration, data collection, coding and analysis. Individuals at terminals will find it all but impossible to enter incorrect responses, or leave items blank. And third, an automated sysstem has the capability of collecting sensitive information from individuals with more confidentiality than traditional methods.

PURPOSE

Since computer administration of surveys is a relatively new phenomenon, little research has been conducted comparing this method with other data collection methods in terms of efficiency and quality of data. While the automation function is straightforward, the effect of the technology on survey responses is yet to be determined. This paper focuses on (1) briefly describing the components and capabilities of one automated survey system being developed for the Navy, (2) outlining some field study results comparing an automated survey with a traditional paper and pencil survey, and (3) delineating some future research issues that impact on individuals and their responses, that may now be easily addressed with automation.

AUTOMATED SURVEY SYSTEM COMPONENTS

The Navy Personnel Research and Development Center is developing an automated survey system to assess the attitudes of the Navy civilian workforce. CENSUS (Computerized Executive Networking Survey System) consists of using microcomputer technology, in particular IBM ATs as host computers. Software specifically designed to allow simultaneous access by several participants in the survey was developed for CENSUS. Surveys are presented to respondents in remote sites by means of Northern Telecom Displayphones that serve as both the telecommunications and terminal input devices. Data are transferred during the time of survey administration to the IBM AT using commercial phone lines. Results are obtained by applying computer programs that combine survey information with existing demographics, providing almost immediate feedback to policy makers about the attitudes of individual segments of the workforce.

The computer technology is being exploited to develop a complete stand-alone survey system capable of being used independently by managers and policy makers, enabling them to interact with menu-driven computer programs and access information much like a decision support system. While each of the survey components is being developed independently as part of a research effort, they will be integrated to form a complete system. The specific components consist of (1) automated survey administration and data collection presently developed as the prototype CENSUS system, (2) automated data analyses on longitudinal survey data bases that have been previously integrated with existing demographic data bases, (3) computerized sampling strategies to identify any segment of the workforce for querrying, (4) a computerized reporting system with management reports, tables and graphs automatically produced, and (5) a computerized authoring system that aids managers unsophisticated in survey design to develop high quality, timely, and useful surveys.

RESULTS OF FIELD TESTS

A prototype CENSUS survey system has been field tested on three separate occasions (twice in San Diego and once in the Washington, DC area) with a sample of 600 identified each time, located in 13 to 16 separate Navy installations. Each survey was conducted during business hours for one week, and focused on civilian personnel issues (e.g., training needs and the retirement system). Response rates were high, ranging from 60% to 85%, depending upon the level of commitment by management to participating in the the survey. Respondents' attitudes toward the survey and the computer were overwhelmingly positive. Virtually no one had difficulty using the terminal, obtaining a phone line, and most anticipated future computerized

surveys. Almost no one refused to use their social security number as an identifier when told that their survey responses would be linked with information in their personnel data bases--even though they were told that participation was voluntary. In addition, participants during the second San Diego survey were asked if they wanted feedback on the results from the first survey. Over 90% chose to view bar graphs and textual material representing selected overall results from the previous survey.

Useful results were presented to policy makers within a week of survey completion. Results demonstrated the feasibility of conducting automated surveys using a microcomputer. In terms of the advantages of timeliness, administration costs, and logistics, automated surveys are an improvement over traditional mail-out paper and pencil surveys.

To test the effects of the automated survey system on individuals' responses, CENSUS was compared to a paper and pencil version of a survey consisting of 60 questions on attitudes toward proposed changes to the civil service retirement system. Previous evidence exists (McBrien, 1985) that respondents view computerized surveys more favorably, find the task easier, and more interesting than paper and pencil surveys. Also, Kiesler & Sproull (1985) and Erdman, Klein, & Geist (1983) found that when comparing electronic surveys to a paper mail surveys, there were fewer completion mistakes, fewer blank items, and fewer refusals to answer questions in the electronic survey. These issues were addressed in the comparison between the two versions of the retirement survey.

The paper and pencil survey on retirement was administered to 46 individuals at a Navy research laboratory located in Maryland during the last week in August, 1985, while an automated version was being administered to a sample of employees in the Washington, DC area in 16 activities (N = 307). Comparisons between a comparable sub-sample of the automated group (N = 27) and paper and pencil group were made to assess the error rate of the respondents on the paper version (e.g., multiple responses and inappropriate branching). All respondents were also encouraged to complete a written comment sheet regarding how they liked/disliked the questions, and for the automated group, how they liked/disliked the computer. Forty-four from the paper and pencil group and 18 from the comparable computer group responded.

Results indicated that 3% of the total responses were in error for the paper and pencil survey, with half of those errors representing incorrect branching, i.e., individuals who did not branch properly when instructed to do so. There were essentially no errors in recorded responses or hardware, software or communications malfunctions for the computerized survey group. Also tested was the reliability of items by repeating three questions at the beginning and end of the questionnaire. Both groups responded essentially the same on the repetition of these items, even though paper and pencil respondents were able to refer back to the initial items later in the survey, and would presumably respond more consistently than the computer respondents. Comments from the computerized survey were overwhelmingly positive toward taking a future survey by computer rather than by paper and pencil. Over 89% of the overall computer group would prefer an automated survey over a traditionally administered survey. The computer group also expressed many written comments regarding the usefulness, importance and belief that their opinions would be considered. One explanation is that people believed the survey was important and valid attitude assessment instrument because it was presented on the computer.

A major aspect of how the technology differentially affects survey responses was in the comments individuals provided as to what they liked about the computerized and paper and pencil versions of the survey. In written responses about the automated version, many individuals responded that they found the survey to be engaging and believed the results would be used by policy makers. Many respondents who answered that they had little knowledge of the retirement system expected the computer to present them with a tutorial concerning retirement benefits, while they paper and pencil respondents had no such expectation. This result highlights the potential of computerized surveys to be used as educational tools, and hence, influence future attitudes.

RESEARCH ISSUES

In general, the research issues focus on exploiting the technology to improve the quality and usefulness of surveys, while developing an understanding of the effects that automation has on individuals and their responses. Two important potential areas of research applying computerized surveys are as follows.

Computerized administration of surveys can make a substantial contribution in collecting responses to sensitive questions. Previously, the method of randomized responses (Warner, 1966; Campbell & Joiner, 1973) has been used to elicit answers to sensitive questions, particularly in situations where people have suspicions about their anonymity. This method requires the individual to respond to a randomly presented question that is either sensitive or not, without the experimenter's knowledge of the specific question being asked. By knowing probabilities associated with answers to known questions, an estimate of the number in the sample who agree with the sensitive questions may be calculated. Some evidence indicates that using computers may elicit fewer socially desirable responses (Kiesler & Sproull, 1985; Kiesler, et al., 1985), and presumably more honest responses. While the content of the retirement surveys reported did not directly ask sensitive questions, there is some evidence that the respondents were willing to disclose their identity, (using social security numbers), and did not feel that doing so changed their responses. Respondents may perceive that completing a survey on an automated system is more anonymous that other methods, and, hence, they may be more willing to disclose personal and sensitive information.

Some advantages of obtaining answers to sensitive questions by computer over the randomized response method are that (1) there are fewer ethical questions when asking individuals questions directly, rather than indirectly, (2) frequency of responses do not have to be estimated, and (3) the computerized system is far less cumbersome and time comsuming to use. This is a particularly potential important application area in military research, where selection of highly trusted personnel to work on classified projects is a top priority, and being able to have confidence in individuals' responses to sensitive issues is essential.

A second area important where the technology of survey systems may have an effect on responses of individuals is in feedback systems within organizations. Historically, surveys have been a device for tapping attitudes and opinions of employees in organizations. However, there was more concern for the measurement issues of the instrument itself than for the informational value or feedback aspects of the system. Currently, as popular management books advocate, there is an emphasis on employee

involvement in decisison making at all levels in organizations. This could lead to a resurgence in the use of surveys, as managers need to better understand the opinions of the employees prior to making decisions that affect their working lives (Hinrichs, 1985). By integrating computerized survey technology into computerized management information systems, comprehensive feedback may be provided that would improve organizational communication, an essential ingredient in the tools of modern management.

Employee involvement in the CENSUS system is evidenced by the interest in receiving feedback and the anticipation for future surveys by the field test respondents. By automating reports of results, policy makers, managers and employees alike will be able to have meaningful and timely feedback on the attitudes of the workforce. Involvement in the organization by individuals at all levels should improve by incorporating the technology of presentation and communication methods. These feedback methods would include improved information displays, such as the enhanced use of graphics (Fienberg, 1979). In addition, a true feedback system will be established when managers become involved in developing questionnaires and accessing the data base, interactively through easy to use menu-driven computer programs. By evaluating the needs of managers, more effective feedback mechanisms will be developed to provide input to future surveys, and will be the final component in the automated survey system.

REFERENCES

(1) Campbell, K. & Joiner, B.L. How to get the answer without being sure you've asked the question. Amer. Statistician, 27(1973) 229-31.

(2) Erdman, H., Klein, M.H., & Greist, J.H. The reliability of a computer interview for drug use/abuse information. Behavior Research Methods & Instrumentation, 15(1983) 66-68.

(3) Fienberg, S.E. Graphical methods in statistics. Amer. Statistician, 33(1979) 165-178.

(4) Hinrichs, J.R. Employee involvement through survey feedback. The Industrial-Organizational Psychologist, 23(1985) 16-18.

(5) Kiesler, S. et al. Affect in computer-mediated communication: an experiment in synchronous terminal-to-terminal discussion. Human-Computer Interaction, 1(1985) 77-103.

(6) Kiesler, S. & Sproull, L.S. Response Effects in the Electronic Survey, 1985 (unpublished paper).

(7) McBrien, B.D. The Role of the Personal Computer in Data Collection, Data Analysis, and Data Presentation: a Case Study, 1985 (unpublished paper).

(8) Nicolls, W.L., II. CATI research and development at the Census Bureau. Sociological Methods & Research, 12 (1983) 191-197.

1 The opinions expressed in this article are those of the authors, are not official, and do not necessarily reflect the views of the Navy Department.

Human Factors in Organizational Design and Management - II
O. Brown, Jr. and H.W. Hendrick (Editors)
Elsevier Science Publishers B.V. (North-Holland), 1986

JAPANESE QUALITY CONTROL: IMPLICATIONS FOR JOB AND ORGANIZATION DESIGN

Steven L. Dockstader

Navy Personnel Research and Development Center
San Diego, California 92152-6800

The Japanese approach to total quality control (TQC) is examined regarding the impact it would have upon job and organization in American companies. Sources of resistance to control systems (Lawler, 1976), and requirements for systems change to meet the requirements of TQC (Metz, 1984) are discussed. Job characteristics theory is used as a conceptual framework to determine the motivating potential of jobs created by adopting the TQC approach.

INTRODUCTION

The purpose of this paper is to examine the characteristics of the Japanese approach to total quality control (TQC), and to determine whether they can effectively be adopted by U.S. organizations. This question was prompted by questions arising in the Department of Defense as to whether the methods used by the Japanese would be applicable to maintenance and service organizations in the public sector. The paper will examine the following questions or issues:

1. What are the characteristics of TQC?
2. What are the principal sources of resistance to TQC?
3. What are the implications of TQC for job and organization design?
4. Can jobs be enriched, and organizations designed, in ways to overcome these sources of resistance?

THE BASIC CHARACTERISTICS OF TOTAL QUALITY CONTROL

The concept of total quality control (TQC) represents an integration of approaches from marketing analysis, process control, and statistical quality control into a comprehensive system of management. Armand Feigenbaum (in Ishikawa, 1985) provided an early and still currently used definition:

> "an effective system for integrating the quality development, quality maintenance, and quality improvement efforts of the various groups in an organization so as to enable production and service at the most economical levels which allow for full customer satisfaction"

Ishikawa goes on to say that quality of product is too narrow a concept and has limited the full elaboration of the total quality management concept in the West. He points out that:

> "Broadly interpreted, quality means quality of work, quality of service, quality of information, quality of process, quality of division, quality of people, including workers, engineers, managers, and executives, quality of systems ... and objectives. To control quality in its every manifestation is our basic approach"

One can begin to understand the meaning of "total" from Ishikawa's definition. Unfortunately, however, these concepts have either been too subtle or their virtues have not been in evidence to the degree required for U.S. organizations to have adopted this management approach. At the heart of total quality control are the methods of statistical quality control. The fundamental objective of these techniques is to achieve control over the process which produces the product or service, such that quality defects or unsatisfactory services never occur. This quality control process can be illustrated in Figures 1 and 2.

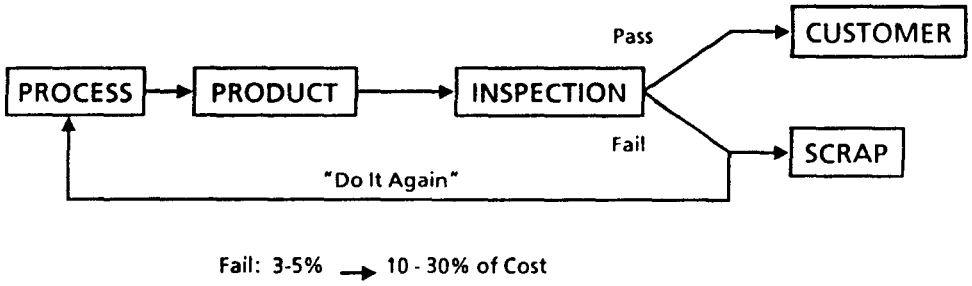

Figure 1
A Flow Diagram of the Inspection Approach to
Product Quality Control

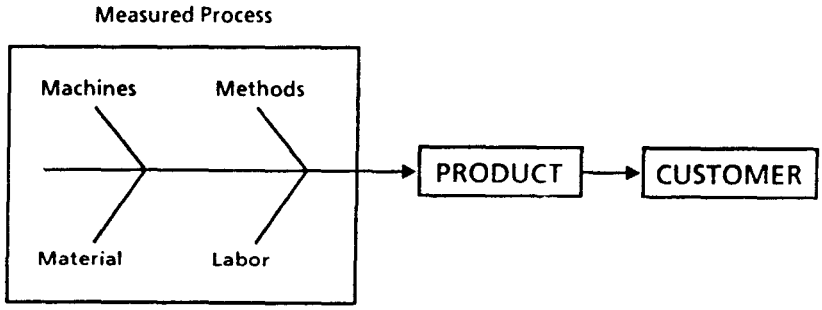

Figure 2
A Flow Diagram of the Process Control
Approach to Product Quality

Figure 1 depicts the typical case in the manufacturing environment. Here, products are produced, some of which are defective and, in order to meet demand, reprocessing is necessary or, in the case of major defects, the product is lost to scrap. In Figure 2, the scenario does not typically include inspection because the components of the process which can produce defects are monitored and controlled. These process components are identified here as four, but these are just the major categories of variables that are measured and controlled using this approach.

Getting back to the definition of "total", the idea is that process quality controls are directed at all of the significant processes in an organization, not just those principally identified with manufacturing. In addition, the philosophy is extended to management processes as well--so that the general strategy is one that can involve all employees at all levels in the organization.

The primary reason for attempting such a comprehensive approach can be found at the bottom of Figure 1: the cost of maintaining quality using the inspection approach can be as high as 30% of the product cost. This was (and is) a particularly critical factor for the Japanese because they have virtually no natural resources and could not afford to scrap any material that would result from faulty processes. When they found that process control methods also lowered labor costs (no reprocessing, less process problems to deal with), this convinced them to apply the approaches outside the manufacturing environment. The rest is history.

SOURCES OF RESISTANCE TO THE TQC APPROACH

Lawler (1976) has analyzed the nature of control systems in organizations and the kinds of resistances to their development. In his analysis, he points out that resistance to control systems is most likely when:

1. The control system measures performance in a new area.
2. The control system replaces a system that people have a high investment in maintaining.
3. The standards for control are set without participation.
4. Control system feedback does not go to those who are measured.
5. Control system feedback goes to higher levels in the organization and is used in the reward system.
6. People affected by the existing system are relatively satisfied and see themselves committed to the organization.
7. The people affected by the system are low in self-esteem and authoritarianism.

Using Lawler's analysis, we can examine the resistance to change from the product inspection approach to the process control approach. Following that, an argument will be made on the basis of contemporary work motivation theory as to why the process control approach should be very successful, once implemented.

In the following discussion, Lawler's seven sources of resistance will be considered in turn for the operations of a large aircraft overhaul facility in the Navy. Although the observations made here are not based upon empirical data, they have been corroborated by senior managers in that organization and by on-site research personnel.

1. The process control approach does measure performance in new areas. In fact, the essence of the approach involves measuring several significant features about the production process prior to completion of a product or service.

2. Ultimately many of the personnel who are cu rently used in the quality control department will be deployed to other parts of the organization, or be conducting quality control activities not currently being performed (e.g., incoming supplies, customer services, etc.). This displacement and/or retraining of personnel is viewed as a threat by those in the current quality control function.

3. Quality control standards are usually established by engineers or quality technicians. In the case of process control, however, a fixed standard has no meaning. Control is defined by taking actions to keep the process within variability limits which are determined by the process itself. Because the limits change as a function of improvements in the system, no fixed standard can be applied.

4. Using the process control approach, the basic data is collected by the performer. In this sense, feedback is immediate. Furthermore, because the information gathered is typically a historical record with relational information on the record (e.g., a control chart), the worker can evaluate the data and determine what actions, if any, need be taken.

5. Whether the data is fed to higher levels and used within the reward system depends upon a number of factors. The most significant is the degree to which the worker has discretion to make decisions concerning corrections to the system. This, in turn, is usually based upon the extent of the system changes and their costs, but could also be a reflection of the management philosophy of the organization. This will be considered in greater detail in a subsequent discussion.

6. This is the "status quo" factor, and it can be said that a change in the inertial state of the organization will be determined by whether or not a "critical mass" (Deming, 1985) can be developed to overcome the status quo. The state of inertia in most bureaucracies, such as those in most large bureaucratic organizations, is at steady state and resistant to change under normal workload conditions.

7. It is difficult to assess this factor. The people most affected by the quality control system are those in the "production" area. As a group, they are the largest in number and exert the greatest influence on achieving the mission of the organization. However, under the current product inspection approach, they receive the most censure when product quality does not meet specifications/test. Managers have been of the opinion that this has led the workers to lose identity with the quality of their products because someone else has been responsible for detecting it.

Lawler has indicated that, to the extent that these factors hold for workers, they will engage in non-productive or even counter productive behaviors. Using his analysis and the previous discussion, it appears that the process control approach should meet less resistance in terms of factors 3, 4, 6, and 7. That is to say that it (a) does not deal with standards per se, (b) provides feedback information to the performer, (c) is of greater benefit to most of the work force than the existing system and (d) can enhance the self esteem of the worker as he begins to take charge of the quality of his work.

Of the other factors, only the second appears to be of significant concern in terms of resistance to change. In the organization under study, quality control is vested in a functional department. While performing inspections or audits of the work conducted in the production area is not their only function, it doe ; define their central raison d'etre. In addition, this organization is one of several which reports to a headquarters. Both the headquarters and the sister organizations contain quality control functions based upon inspection and audit. Resistance here would have to be overcome.

Factors 1 and 5 are potentially areas of resistance because of the new measures and added work required (1) and because the information could be used to evaluate performance of the workers (5). Neither of these is necessarily negative, but the work force is often wary concerning the use of performance measures. If the

management philosophy and the culture of the organization is one that rewards improvement then there will be little resistance.

PROCESS CONTROL AND WORKER MOTIVATION

Our discussion thus far has focused on the desirability of changing from product inspection to process control and the nature of resistances in making such a change. While it appears obvious that such a change is both desirable and feasible from a management standpoint, what is in it for the worker? After all, with the exception of some of the existing quality control personnel, the major job changes will be that of the worker and perhaps his immediate supervisor. If this change is not seen by the worker as having incentive value, then it will very likely be resisted.

Job Characteristics Theory (Hackman & Lawler, 1971; Hackman & Oldham, 1976) provides a conceptual framework to evaluate the design of a workers job to include the process control approach to quality control. The theory is based upon a plethora of research which has revealed that there are three psychological states which contribute to worker motivation. These are feelings of meaningfulness, responsibility, and knowledge of results. The theory goes on to describe what job characteristics will result in these feelings. The theoretical relationships can be schematicized as follows:

Table 1
A Model of the Effects of Job Characteristics
(After Hackman & Oldham, 1975)

Five Core Characteristics		Psychological States		Outcomes
Skill Variety Task Identity Task Significance	→	Feeling of meaningfulness	→	High intrinsic motivation High quality work
Autonomy	→	Feeling of responsibility	→	High satisfaction
Feedback	→	Knowledge of results	→	Low absenteeism and turnover

Considering each of these characteristics in turn, we can determine the motivating potential, or incentive, of the workers job when process control becomes a part of the job. Skill variety is obviously increased because the job will now involve collection of data, charting of data, and reporting process aberrations. Task identity should increase because attention will be focused on aspects of the process which were previously receiving less formal, e.g., measurement, attention. The perceived significance of the task may also be enhanced because taking process control actions should occasion interaction with supervisors, staff, and managers which would not ordinarily occur. Autonomy will be increased because quality control actions and responsibilities will now be formally placed in the hands of the worker. Finally, feedback will be immediate in terms of the things being measured. Feedback as a result of process changes will, in most cases, be immediate as well.

From this logical analysis and the model displayed in Table 1, we can predict the outcomes displayed there. During the course of the forthcoming year, these hypothetical relationships will be tested in the Navy maintenance environment. The use of process control as a method to enrich jobs has not received attention in the empirical literature, but the aforementioned analysis suggests that it should be an effective way to motivate workers as well as increase the quality of their efforts.

SOURCES OF RESISTANCE IN ORGANIZATION AND MANAGEMENT

Job characteristics theory paints an optimistic picture with regard to the success potential of the TQC approach--at least at the level of basic process control. However, unlocking the motivating potential of TQC means more than forming quality circles at the worker level--it means taking a systems view of processes and how they are managed. The remainder of this paper will be directed at exploring four arguments for why, despite the proven benefits of the TQC approach, it will be greatly resisted in most organizations. These are:

1. Seven of the most fundamental assumptions of TQC are counter to the existing quality assurance culture.

2. For several decades, management development in the U.S. has been based upon financial control systems and those managers currently in power have no stake in change.

3. Most organizations fail to recognize that productivity and quality improvements of the order implied by TQC require an integrated and strategic change process.

4. Except in organizations where an economic threat is perceived, there is no felt need for change.

In his article, Metz (1984) quite correctly argued that TQC requires a holistic organizational view that may involve a cultural change. In work conducted by myself and my colleagues (Dockstader, 1984; Houston, Shettel-Neuber & Sheposh, 1986) the elements of cultural change for a sample of major American corporations and for large Navy organizations were identified as:

1. Changing the production focus to an emphasis on the quality dimension from the current quantity focus.
2. Adopting process control and eliminating inspection.
3. A need to understand the systemic causes of quality problems and to change the attitude that most are the direct result of poor workmanship.
4. Process control decisions should be data based rather than quick reactions to unknown causes.
5. Continuous improvement of processes does not lead to increased cost--the opposite is true.
6. The benefits of quality improvement accelerate with time, so a long term commitment is necessary.
7. Quality is a fundamental responsibility of all employees, not just production workers and/or quality assurance personnel.

In the culture of most U.S. organizations, these "facts" of TQC are resisted because they are counter to existing management styles and beliefs. Deming (1985) explains American reluctance to accept these facts in terms of (a) attitudes formed by management which were largely superstitious in nature and (b) a style of management

that has evolved resulting from selecting and promoting managers with financial management training.

Deming's argument concerning superstitious behavior is based upon his observation that the U.S. controlled most of the world markets following World War II and, in this environment, even the most wasteful and non-controlled of production systems were rewarded due to market demand. This was further exacerbated by the fact that the U.S. had tremendous natural resources and a large and willing work force so that any concern with scrap, waste, or even human resources was very low. Any management practice, he says, could succeed in this environment.

His second argument is that during the same period, banking and commerce became increasingly important in our society and, with the boom going on in production, corporate attention moved from production systems to those of financial management. Emphases in education then shifted from engineering and production management to the business schools. With more and more corporate managers being drawn from these ranks, there was less and less talent involved in production management. This situation resulted in an elaboration of financial management systems by people who had little process and product knowledge. This view has been supported by the findings of Tuttle, Sink & DeVries (1984) who have indicated that the model of organizational effectiveness used by most U.S. businesses is one which is driven (backwards) by financial outcomes, rather than by operational objectives.

If Deming's assessment is correct, the preponderance of managers are not knowledgeable concerning the processes upon which their enterprise is based. If this premise is true, then they are probably driven by demand for short term profits and evaluated in terms of short term gains which is at odds with a TQC philosophy that views quality improvement as a long term and continuous activity. In addition, the audit orientation of financial managers would probably find valid the idea of inspection the only "real" way to assure quality. Finally, the annual system of appraisal which has rewarded this kind of thinking and behavior for the last several decades will continue to promote it--or encourage job hopping when things appear to be on the down side.

In view of these observations, and the pressures that schedule places on the production managers, it is difficult to view the managers job as one that would be enhanced--in the near term--by process control methods. Even though an argument can be made that controlled processes dramatically reduce the myriad of daily problems that face managers--most managers are unaware of the need for or the methods by which to consciously redesign an organizational system or culture. This latter point was made by Metz (1984) in his analysis of the characteristics of approaches for implementing quality improvements. They range from short term "programs" with little management involvement to long term socio-technical interventions with continuing top-level involvement. In his analysis, TQC (identified as statistical quality control) is one of the latter. I have paraphrased, within the context of TQC, the set of prescriptions he makes as the basis for undertaking a redesign effort:

1. Development of a quality management philosophy.
2. Definition of goals and values to introduce clarity, consensus, and commitment to quality.
3. Organization of a transition steering committee which will define and plan for the future state.
4. Development of a strategic change plan which, when fully implemented, would place TQC as the paramount management system.

While these prescriptions make a great deal of sense regarding a "roadmap" for cultural and organizational change, they do not deal with a basic assumption of all change theory--the perceived and felt need for change. Clearly, organizations studied by Houston et al. (1986) all felt the loss of market share and the threat of even greater disaster. But, for organizations not currently threatened by the successes of Japan and those relatively immune to the free market economy (e.g. most public sector organizations) the only hope of overcoming the inertia of history is continuous leadership with great vision.

SUMMARY AND CONCLUSIONS

The feasibility of extending statistical process controls to management of all organizational processes was examined in the context of (a) resistance to control systems and (b) social and historical factors influencing management and organizations. Job characteristics theory was used to explain the motivating potential of such an approach at the level of basic operations, where it was revealed that great potential exists for the enrichment of the job of the great number of workers making up the base of the organizational pyramid. For most managers, however, it is much less obvious how the approach could have the immediate positive impact upon their work, requiring them to re-examine their existing assumptions and approach. Finally, although a roadmap for socio-technical change to the total quality approach can be developed from existing organizational development knowledge, it is not apparent to most managers that the change is required.

REFERENCES

(1) Deming, W.E. Transformation of western style of management, Interfaces, 15 (1985) 6-11.

(2) Dockstader, S.L. What to do when there are more than five deadly diseases. Paper presented at the MIT conference on Managing Systems and People for Quality Improvement, San Diego, 29 June 1984.

(3) Hackman, J.R. and Lawler, E.E. Employee reactions to job characteristics, Journal of Applied Psychology, 55 (1971) 259-286.

(4) Hackman, J.R. and Oldham, G.R. Development of the job diagnostic survey, Journal of Applied Psychology, 60 (1975) 159-170.

(5) Houston, A., Shettel-Neuber, J., and Sheposh, J. Management methods for quality improvement based on process analysis and control. Technical Report, Navy Personnel Research and Development Center, San Diego, CA (1986).

(6) Ishikawa, K. What is total quality control the Japanese way? (Prentice-Hall, Englewood Cliffs, NJ, USA, 1985).

(7) Lawler, E.E., Control systems in organizations, in: Dunnette, M.D. (Ed.) Handbook of Industrial and Organizational Psychology (Rand McNally, Chicago, IL, 1976).

(8) Metz, E.J. Managing change: implementing productivity and quality improvements, National Productivity Review, Summer (1984) 303-314.

(9) Tuttle, T. Sink, S. and DeVries, P. Productivity measurement and evaluation: what is available, National Productivity Review, Summer (1984) 265-287.

Human Factors in Organizational Design and Management - II
O. Brown, Jr. and H.W. Hendrick (Editors)
Elsevier Science Publishers B.V. (North-Holland), 1986

CONTRIBUTION OF A MULTI-METHOD APPROACH TO UNDERSTANDING IMPLEMENTATION

John P. Sheposh, Ph.D.
Joyce Shettel-Neuber, Ph.D.

Navy Personnel Research and Development Center
San Diego, California

This paper describes an approach which blends grounded theory with an existing management theory to better understand the status of a newly implemented quality improvement program. Information used for the development of the grounded theory was obtained through a case study technique and artisans' perceptions of work impediments. The theoretical framework employed was Likert's Profile of Organizational Characteristics (1967). While each technique provided useful information, in combination these three sources of information made a more powerful and more reliable diagnostic tool.

Many private and public sector organizations in the U.S. are currently initiating organization-wide quality improvement efforts. Due to the large-scale investment of time, effort, and money required to implement such a program, it would be useful to identify, measure, and track those organizational characteristics which are likely to promote or inhibit the implementation of an organization-wide quality control effort.

With respect to the measurement and identification of organizational features important to implementation efforts in general, there has been a growing emphasis on the use of grounded theory (Dunn & Swierczek, 1977). Rather than applying on an a priori basis an existing theory to a specific implementation or change effort, a grounded theory approach proposes that a model or theory be developed directly from the observations of events and processes embedded in that organization. On the other side of the coin, there recently has been expressed a concern over the atheoretical, open-ended nature of evaluating implementation of organizational change and the need for the use of a theory-driven approach (the use of existing theoretical knowledge) in the service of change evaluation (Chen and Rossi, 1983). This paper reports on the application of both of these seemingly contradictory approaches in assessing the status of a newly implemented quality program.

APPROACH

The implementation effort described in this paper is presently being carried out at a Naval Air Rework Facility (NARF). One of the production divisions (Components and Metal) and its related support divisions at this facility have been the major focus of the implementation effort to this point in time. The basic components of the implementation effort, which are characteristic of a Total Quality Control (TQC) orientation, include: (a) the application of statistical tools and techniques to improve everyday work processes, (b) extensive training and retraining in these methods, (c) a greater degree of participative management, quality activities carried out in all

functional disciplines, and (d) an organizational structure that consists of quality boards at all levels of the organization (Ackoff, 1981; see Figure 1). Concerning this last point, the boards established here were designed to provide a mechanism to facilitate both vertical and horizontal communication concerning work processes and quality activities necessary to the implementation of TQC. This system of interlinking boards was adopted to insure that the quality improvement effort would be focused and yet extend across all departments within the Components and Metal building.

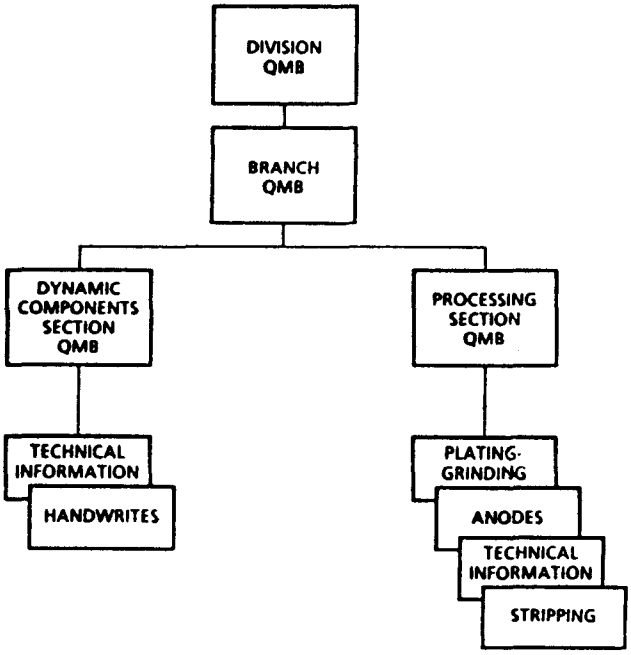

Figure 1
Components and Metal Building
Implementation Structure

A TQC implementation effort, such as that being undertaken by the NARF, has as its aim the cultivation of certain organizational characteristics (Ishikawa, 1985). These include (a) quality as the primary aim, (b) a consumer orientation, (c) the removal of sectionalism, (d) the use of statistical methods, (e) the use of participatory management, and (f) cross-functional management. It is evident that attaining these TQC characteristics may require a fundamental organizational change in the direction of more participatory management (i.e. individuals are asked their opinions and allowed to contribute at all stages of the process). The organizational change anticipated with the implementation of TQC is compatible with some existing organizational theory. One theory that is particularly relevant is Likert's (1967) concept of organizations. The organizational characteristics recommended for an environment conducive to TQC are very similar to the ones characterized in Likert's most highly evolved management system, as measured by his Profile of Organizational Characteristics (1967). The Profile of Organizational Characteristics (POC), therefore, could be a useful instrument to use in the assessment of a TQC implementation. We reasoned that an organization that has difficulties in implementing this type of program would be characterized by a lower level management system. Furthermore, the greater the progress in implementing this

program, the more likely there would be a shift to a higher level management system. As part of a series of assessments of the management system, the first assessment was given in May 1985 to 33 supervisors representing seven departments which perform the work processes in the Components and Metal Division.

In order to collect information that might be useful in the development of a grounded theory of TQC in this particular setting, two sources of information were tapped: (1) perceptions of 59 artisans concerning the aspects of the organization that impede work performance, and (2) information bearing on the day-to-day implementation effort which was obtained by means of a case study approach. The case studies also enabled us to document the outcomes resulting from implementation activities. The case studies described three of the project teams (Plating-Grinding, Anodes, and Technical Information), that are at the lowest level of the board structure (see Figure 1). The authors attended meetings and documented the progress of these groups from May 1985 through January 1986.

FINDINGS

The case study analysis of the project teams provided information regarding the results achieved by the teams and the progress of the implementation effort. Table 1 presents the outcomes obtained by the three project teams. All three teams realized some improvements as a result of their efforts. Some of the benefits derived from the projects were: the reduction of additional reworking of aircraft components, greater control over work procedures, and an enhanced atmosphere of interdepartmental and cross functional cooperation. This final result is not surprising considering the cooperation that is indicated by the variety and number of work units required to address each issue, as shown in Table 1.

Table 1
Project Team Outcomes

Project Team	Objective	Work Units	Results
Plating-Grinding	Reduce reprocessing in grind-plate-grind cycle	Engineering Quality Assurance Production Control Production Engineering Production	o Better communication between Plating and Grinding o Significant reduction in process variability o More accurate identification of rejects
Anode Cleaning	Develop improved method for cleaning utility anodes	Engineering Production Engineering Production	o New method found to be effective (Savings: $300 per replacement anode) o Anticipated improvements in reliability of chrome application
Technical Information	Improve control over technical information	Quality Assurance Production Engineering Tech Data Center Production	o Better communication channels and procedures established o Tech data in E&R shop updated o Procedures established for continual updating of tech data

A second set of results relate to indicators of the progress of the implementation. We felt that one set of indicators would be the nature of the actions taken by these teams. The extent to which actions such as these were carried out in the project team areas would be indicative of the vitality of the TQC implementation. As indicated in Table 2, the teams were moderately to highly successful on the following: they established communication links where necessary, developed procedures designed to reduce variation in their work processes, and attempted to employ measures of the process. All of these activities represent a departure from

Table 2
Indicators of Implementation Progress

Project Team	Actions Taken	Difficulties Encountered
Plating-Grinding	o Measurement system for process monitoring established o Communication link established between shops	o Insufficient collection and application of objective data o Reluctance to use obtained data to improve work processes
Anode Cleaning	o Tested new work method to improve process of utility anode cleaning o Established procedure to pull and clean anodes every 6 weeks	o Reliance on on-the-job experience rather than on data o Lack of process measurement and monitoring
Technical Information	o Work material organized and updated o Procedures established for better control over process o Communication link established	o Difficulty in linking concept of quality to non-production area o Difficulty in determining scope of the project o Less than optimal use of measurement o Insufficient communication between project team and upper boards

the way they typically conducted their work and are representative of a TQC approach. The case studies also revealed areas that are problematic for this approach. As indicated in Table 2, there have been difficulties in establishing the routine use of measurement, both for monitoring, control, and improvement of purposes. In addition, the projects are not clearly tied to a larger, overall effort. This is exemplified by the fact that the findings and recommendations from all of the project teams have not been presented to boards above the Section QMB level. The status of the boards was partially a result of resistance and partially a lack of planning regarding the implementation. The problems then appear to be at the management level. Management, either through the QMBs or the regular communication channels, did not provide adequate support and information regarding the implementation effort to personnel. The purpose, breadth, and elements of the TQC effort were not fully understood by personnel. Management did not display the visible active, and consistent involvement that is required to indicate a high degree of commitment. The data concerning artisans' views of work impediments are pertinent here (see Table 3). It is interesting to note that when several months earlier we assessed workers' perceptions of their jobs, the impediments most frequently cited as keeping them from doing their best work were systems problems (e.g., poor planning, waiting for parts and supplies, supervisors not listening, and

Table 3
Percentage of Artisans Indicating Factors Which Were Impediments to the Performance of Their Job[a]

1	Poor planning	64.5[b]
2	Stopping one thing to start another	62.6
3	Disciplinary standards inconsistent	59.4
4	Waiting for parts/supplies	50.9
5	Not having right equipment/tools	47.5
6	Others not doing their job	47.5
7	Mismatched parts/paperwork	47.5
8	Poor on-the-job training	45.8
9	Supervisors not listening	44.1
10	Too much expected during 8-hour shift	42.4
11	Unclear/conflicting orders/instructions	40.7
12	Poor working conditions	39.1
13	Paperwork unclear/different	37.3

[a] Total number of impediments were 26
[b] Percentage who marked "a great deal" or above on the scale

unclear or conflicting orders and instructions), which are in the province of management.

Our characterization of management's role regarding the status of the implementation--their commitment, degree of understanding, and acceptance of TQC--was enhanced by the results of the POC, which were obtained several months earlier. The means for the 49 items on the POC can be identified as following into one of the four types of management systems identified by the POC (see Figure 2). In this administration, 37 of the means fell in the lower half of System 3 (Consultative Style) and 12 were in System 2 (Benevolent Authoritative Style). In general, the pattern can be characterized as falling short of higher levels that theoretically should be compatible with TQC. The profile illustrated in Figure 2 describes a system in which: responsibility for achieving organizational goals rests with management, there is a moderate amount of cooperative teamwork, and

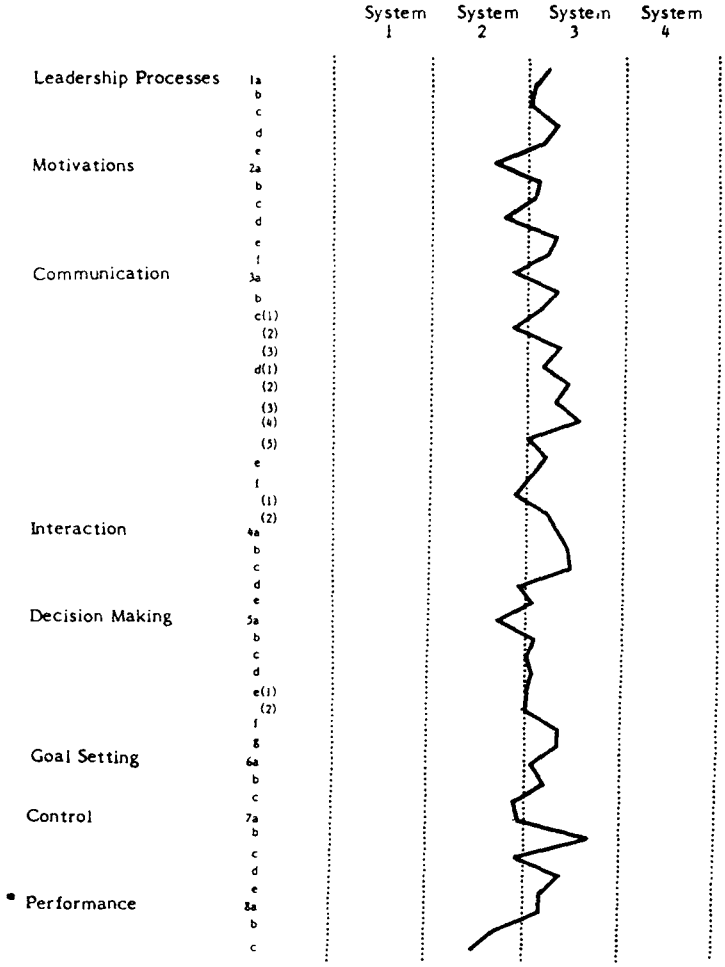

Figure 2
Mean Responses of Managers to POC

subordinates have some influence on goals, methods, and activities in their units. The initial assessment indicates that the management system operating at that time set practices that were not best suited for adopting and carrying out the implementation of TQC.

IMPLICATIONS

The information obtained through case studies, the responses of artisans to the impediments questionnaire, and the results from the POC were each useful. In combination, however, the three sources of information make a more powerful diagnostic tool. They have suggested areas for further investigation as well as indicated some of the areas that need a greater degree of attention in the implementation. From an evaluation perspective, these findings can serve a formative function by providing feedback that would be useful to those involved in the implementation effort. Further, we are in the process of collecting a second wave of data from these three sources. If we find, for example, that the perceived impediments have been reduced in a significant fashion, this is evidence not only for the success of the implementation to this point in time but also bodes well for continued progress. Overall, the results of this continuing assessment may help to determine the interrelationships between such a quality effort and aspects of the organization, leading to the development of a theoretical model and the identification of important components of such an effort. Information obtained in such an assessment effort (a) may aid in the identification of conditions necessary for a broad-based, sustained change, (b) provides a framework with which to test alternate hypotheses regarding the organizational effects of implementing TQC , and (c) may identify aspects of change accompanying TQC which have implications for other areas of organizational change.

REFERENCES

(1) Dunn, W.N., & Swierczek, F.W., Planned organizational change: Toward grounded theory, Journal of Applied Behavioral Science, 13(2) (1977) 135-157.

(2) Chen, H-T., & Rossi, P.H., Evaluating with sense: The theory-driven approach, Evaluation Review 7(3) (1983) 283-302.

(3) Ackoff, R.A., Creating the corporate future (John Wiley & Sons, New York, 1981).

(4) Ishikawa, K., What is total quality control? (Prentice-Hall, Englewood Cliffs, N.J., 1985).

(5) Likert, R., The human organization: Its management and value (McGraw-Hill Book Company, New York, 1967).

Human Factors in Organizational Design and Management - II
O. Brown, Jr. and H.W. Hendrick (Editors)
Elsevier Science Publishers B.V. (North-Holland), 1986

DIFFUSION OF SOCIOTECHNICAL DESIGN FOLLOWING INTERVENTION: A CASE STUDY OF ORGANIZATIONAL LEARNING

Mark F. Levine

Department of Management
California State University
Chico, CA 95929-0005

Bela Feher

Organizational Systems Department
Navy Personnel R & D Center
San Diego, CA 92152-6800

This action research project used sociotechnical systems analysis and design to identify and implement changes in organization structure and functioning to complement a prior shop-level change to semiautonomous work teams in a shore-based Navy repair system. During the researchers' temporary disengagement from the client system, members implemented further changes applying sociotechnical concepts. These changes are examined in terms of organizational learning concepts.

INTRODUCTION

Action research as a framework for planned organizational change sets forth two objectives: to improve organizational performance and to contribute to scientific knowledge. The sociotechnical systems (STS) approach to organization design was developed in the action research framework, yielding a worthwhile interplay of practice and theory in such domains as work system design and the process of change (Clark, 1972). As one aspect of the change process, STS strongly advocates participation on the part of organization members who would be affected by subsequent redesign. The research evidence supports this position in that participation by organization members in planned change has been found to reduce resistance, enhance commitment, and decrease time required to achieve the higher performance potential of the new system design (Davis & Cherns, 1975a,b). In addition to performance benefits of participation, organizations can theoretically acquire the conceptual and experiential bases necessary to take ownership of the change efforts and carry on the process independent of external expertise. Member participation in organization change thereby provides excellent opportunities to extend scientific knowledge in the area of organizational learning. Unfortunately, these opportunities have not frequently been pursued.

In their recent review of the literature on organizational learning, Fiol and Lyles (1985) identified two difficult areas that must be addressed to overcome this deficiency: definition and measurement. With respect to definition they cite a variety of inconsistent perspectives in the literature. They define organization learning as "the development of insights, knowledge, and associations between past actions, the effectiveness of those actions, and future actions" (p. 811). They present the construct of organizational learning as having two components: (1) content, either cognitive or behavioral (or both); and (2) level of learning in the cognitive domain, from fine-tuning within an existing organizational paradigm (low-level learning) to restructuring of the paradigm itself (high-level learning).

Thus, in conjunction with organizational change, a range of potential learning can occur on the part of the organization. Changes in organizational structure and functioning (behavior)

The views expressed in this paper are those of the authors and not necessarily the Navy Department. This is work of United States government employees and not copyrightable.

may or may not be accompanied by an understanding of the underlying concepts (cognitive) shared among members. The level of cognitive learning may also vary from refinements within an established interpretation system (Daft & Weick, 1984) directed toward immediate outcomes (low-level learning) to creation of new organizational paradigms or interpretive schemas that result in long-term effects on organizational structure and functioning (high-level learning). Thus, low-level cognitive development involves the integration of new events into existing organizational systems; whereas, high-level cognitive development is demonstrated by organization members using prior change episodes as initial building blocks of a new organizational paradigm. Associated with high levels of learning is the necessity of unlearning (Hedberg, 1981). In order to realize new norms, values, behaviors, and system functioning associated with high-level learning, old interpretive frameworks and practices must be displaced.

Each component of organizational learning has associated measurement problems. Ideally, cognitive development over time could be measured either by interviews or by using paper and pencil assessments. However, shared interpretation systems do not necessarily find expression in consistent organizational actions. Behavioral development can be demonstrated by actions taken within the context of planned organizational change efforts. Yet changes in organizational action do not assure that the actions were a result of shared, well-understood cognitive schemas, rather than sheer intuition.

Ideally, a measure of both cognitive and behavioral development and analysis of the relationship between the two would provide insight into the complex phenomena of organizational learning. The present case study is an initial attempt to examine organizational learning associated with an STS design program.

THE CASE

Organizational Setting

The case is set in the Navy Shore Intermediate Maintenance Activity (SIMA) in San Diego, California. This SIMA is part of a network of afloat and shore installations that provide maintenance support to the fleet. All are manned and managed by military personnel. This SIMA is the largest, with 2000 personnel in 57 repair shops organized into 5 branches.

Initial Shop-level Change at SIMA San Diego

The traditionally organized Pump Shop at SIMA, designed on the principle of job fractionation, had experienced low productivity, high rework, and difficulty in meeting production schedules. The shop was organized as two large work sections of 15-20 persons. One section was responsible for removal of pumps from the ships, disassembly, ordering parts, and farming out components to assist work centers. The other section reassembled the pumps, tested them, and reinstalled them aboard the customer ships.

SIMA command charged a new Machinery Branch Officer with the task of improving shop performance. He accomplished this by reorganizing the shop around work teams that were given "cradle to grave" responsibility for the repair of assigned pumps. Productivity, adjusted for changes in manning, increased 40% (Levine & Feher, 1985). In light of this apparent success, SIMA command requested that the Navy Personnel Research and Development Center (NAVPERSRANDCEN) evaluate the team concept used in the Pump Shop and recommend ways to improve and institutionalize it.

Collaborative Sociotechnical System Design

The project was a collaborative effort between the researchers from NAVPERSRANDCEN and the management and staff of SIMA to diagnose present organizational functioning,

identify problem areas, generate alternative solutions, critically evaluate and recommend preferred solutions, and facilitate implementation of approved changes. These activities were carried out by a task force whose membership included the authors and a diagonal slice of organization members who had relevant knowledge of and responsibility for pump repair.

Structured and unstructured interviews, observation, and analysis of historical records were used by the task force during the first phase of the study to gain an understanding of the pump repair process. This initial analysis ascertained that the work team design was well suited to the environmental conditions, task demands, and personnel training requirements, as demonstrated by improved output and reduced rework. However, continuing problems in the pump repair process were attributed to a limited perspective in previous changes, i.e., only the core operations in pump repair were reorganized, leaving ancillary support and assist functions largely untouched, requiring diversion of productive resources from the pump teams (Feher & Levine, 1984). Further, analysis of the pump repair system included a scan of the pump shop environment, an examination of the internal operations of pump teams within the shop, and assessment of the work relations between the shop and its primary assist work centers and staff support functions. Redesign based on these analyses produced a series of recommendations for changes to overcome these deficiencies (Feher & Levine, 1985a,b). The commanding officer approved the actions recommended and sanctioned implementation of the changes.

Changes in the Pump Shop's Relationship with the Electrical Shop

The integration of electricians from the Electrical Shop into the Pump Shop was the first change implemented in the pump repair system. This gave Pump Shop management control over the resources necessary to repair close coupled pumps (60% of shop workload). Initially, the task force called for the formation of teams in the Electrical Shop to reduce the fractionation of work on all electrical motors. They further recommended that specific teams of electricians be aligned with pump teams to integrate the work on close coupled pumps. After the commanding officer's acceptance of the recommendation, the task force requested that Electrical Branch management review the recommended change and either implement it or propose an alternative to accomplish the same end.

The response of Electrical Branch management was to develop an alternative solution that was approved and implemented over the next month. Fourteen electricians and one supervisor were reassigned to the Machinery Branch to form a motor repair team within the Pump Shop to handle all close coupled pump motors.

Changes in the Pump Shop's Relationship with the Machine Shop

Three problems were identified in analysis of the Machine Shop's role in the pump repair system: (1) lack of accountability for timely completion of all parts of a job because each part was individually scheduled through the shop; (2) time delays in moving parts between successive sections within the Machine Shop (e.g., lathe, grind); and (3) lack of any mechanism for tracking all components of a job. To address these problems the task force decided to explore the possibility of reorganizing the Machine Shop into two product-oriented clusters (pumps and motors; other components), each capable of performing all machining operations for the products it processed.

A collaborative analysis was made of shop inputs (present loading of each Machine Shop section by product source) to determine the feasibility of such a reorganization. It was concluded that the reorganization was possible, but the task force was divided over the new demands it would place upon the Machine Shop section foremen. The shopmaster, representing the section foremen, expressed strong reservations because the reorganization would require supervision across the entire range of machining operations as opposed to traditional specialization by machine type.

The pros and cons of the proposed reorganization were debated during a formal task force meeting. After two hours a consensus was reached to implement on a trial basis an alternative proposal presented by the shopmaster. The work acceptance function in the Machine Shop was changed so that the two shop planners specialized in products originating from certain shops and became responsible for scheduling and tracking the work on all parts related to each job within their domain (e.g., pumps and motors). This proposal addresses the three problems identified above, but shifts the responsibility and accountability for improvement from section foremen to the planners. So far the change appears to be successful; however, continuing increase in demands on the pump repair system might require reexamination of the concept of reorganizing the Machine Shop into product clusters.

Changes in the Pump Shop's Relationship with SIMA Support Functions

Implementation of changes in the planning of pump repair was more complex due to the involvement of a greater number of people in the task force. Evaluation of the relationship between the Planning Department and pump repair revealed two important concerns. First, considerable shop production resources were being spent in duplicating Planning Department efforts pertaining to ship checks and the procurement of technical documentation. Second, in cases involving revisions and emergent work, delays of three or four days were common due to centralization of the planning function.

Recognition of these concerns led the task force to recommend that planning after a ship's arrival should be moved to the shop. The civilian head of the Planning Department, a task force member, expressed strong reservations about decentralizing any aspect of the planning function. It is possible that such reservations arose partially due to his civil service status which relates scope of responsibility and number of subordinates to pay grade and promotion. After debate during a formal task force meeting, a consensus was reached to implement a three-month trial period for shop planners following one month of training. Shop planners became a permanent feature of the pump repair system following the trial period.

Reallocation of Space

Once the task force reached a consensus regarding the changes within the shop, between the shop and its assist work centers, and between the shop and SIMA support functions, it became apparent that additional space within the building was needed. To accomplish this, two shops unrelated to pumps had to be moved out of the building. Fortunately, a new building was just being completed in which potentially desirable space was available. Unfortunately, that space was previously designated to other SIMA functions. The task force ultimately recommended that some of the new space be redesignated to those shops that needed to be moved. The task force argued that pump repair is one of the most critical to SIMA customers and, therefore, should take priority over other intended use of the space. The commanding officer concurred and space in the building was reallocated.

Continuation of the Change Process by Organization Members

When NAVPERSRANDCEN had fulfilled its charge, it disengaged from the client system. Over the subsequent seven months, normal personnel turnover in SIMA included the Machinery Branch Officer over the Pump Shop and the Repair Officer responsible for scheduling and coordinating SIMA-wide production and customer liaison. During the interim, NAVPERSRANDCEN was charged with applying the STS analysis and design method to the entire regional system of intermediate maintenance. This led to reestablishment of relationships with SIMA, where it was discovered that system redesign activities had continued.

Noting the similarity of operational requirements between the Valve and Pump Shops, the new Machinery Branch Officer had transferred the concept of team-based organization to

valve repair, including shop-level planning and scheduling and tracking of work in the Machine Shop. The Repair Officer went further than simply transferring ideas. He introduced fundamental changes, affecting organization-wide functioning, that pertained to material expediting and customer liaison. In each instance, teams were formed and assigned responsibility for a group of ships. Teams provided one point of contact for all related system functioning and improved depth of expertise in performance of these functions.

DISCUSSION AND CONCLUSIONS

The case demonstrates that participation of organization members in a sociotechnical redesign project can result in both behavioral and cognitive organizational learning. The initial change to teams in the Pump Shop was a fundamental change in organization and operation based on individual intuition. Top management's reaction to the success of the initial change to teams in the Pump Shop, implemented without an organization-wide paradigm shift, was to question the teams' long-term viability given planned high levels of personnel turnover (60% yearly). Ultimately, the success of the changes in the Pump Shop challenged the old organizational paradigm and began the process of cognitive development, involving both unlearning and replacement.

The follow-on sociotechnical redesign intervention brought about complementary changes throughout the pump repair system to capitalize on the advantages of teams (cross-training, motivation, accountability) and give them long-term viability. It also produced an important insight, helping form a new organizational paradigm: that changes at the organizational level were necessary in both assist work centers (e.g., Electrical, Machine) and in a critical staff support function (i.e., Planning) to complement the change to teams at the shop level.

When the NAVPERSRANDCEN research team disengaged from the client, there was opportunity for continued cognitive development. This occurred and involved players who were not active participants in earlier changes. Apparently STS design concepts and their potential for application diffused in the organization. New expectations regarding productivity of pump repairs easily transferred to the adjacent valve repair group through shared management. Management desire for greater depth of personnel expertise readied it to give up previous preferences for worker specialization. As a result, the new Machinery Branch Officer was able to transfer the team concept to valve repair, demonstrating low-level cognitive development.

Efforts by the new SIMA Repair Officer to create teams in related subsystems such as material expediting and customer liaison reflect a shift from the traditional bureaucratic paradigm to the STS model. These changes in perceptions and action went beyond duplication. The changes in customer liaison arose from customer demands that highlighted inadequacies of the traditional approach to customer liaison that relied on individual expertise and motivation. Teams were recognized to offer the advantages of broader expertise and geographic flexibility. Similar dynamics produced the change in material expediting. These changes are evidence of a new cognitive framework for interpreting complex system interrelationships (i.e., high-level cognitive learning).

This analysis of organizational learning highlights a number of theoretical and methodological issues. Although it is theoretically elegant, the distinction of behavioral and cognitive organizational learning is difficult to maintain in practice, requiring judgment of the extent to which action was the result of previous knowledge or of an insightful or serendipitous convergence of events. With regard to the level of learning, it is difficult to discern when a paradigm shift, defining high-level cognitive learning, occurs. Conceptually, a new paradigm must be shared throughout the organization, but total consensus must be recognized as unrealistic in terms of either necessity or feasibility. Both newness and pervasiveness of the shift are difficult to assess. Furthermore, consensus must be developed regarding delineation between organizational and individual learning. This may be particularly important in

nonmilitary settings where turnover of key personnel is much lower. From another perspective, lack of mobility of key personnel may hinder the organizational unlearning required to realize high-level cognitive development. Clarification of these issues would enable more precise and thorough measurement of the construct.

With respect to methodological issues, more rigorous research into organizational learning will first require clarification of the operational definition of the construct. A methodology for monitoring cognitive learning over time by multiple participants in the client system also must be developed. However, need for such dynamic assessment raises the spector of sensitization and obtrusiveness. An alternative approach might avoid the implied aggregation issues by using true organizational indicators of learning, such as SOPs, organization myths, or responses to ambiguous informational stimuli. In the spirit of action research, it is hoped that this study provides both insight into the difficulties and encouragement toward addressing the conceptual and measurement issues.

REFERENCES

[1] Clark, P.A. (1972). *Organizational design: Theory and practice.* London: Tavistock Publications.

[2] Daft, R.L., and Weick, K.E. (1984). Toward a model of organizations as interpretation systems. *Academy of Management Review*, 9(2), 284-295.

[3] Davis, L.E., and Cherns, A. (Eds.) (1975a). *Quality of working life: Problems, prospects, and state of the art.* New York: Free Press.

[4] Davis, L.E., and Cherns, A. (Eds.) (1975b). *Quality of working life: Cases and commentary.* New York: Free Press.

[5] Feher, B., and Levine, M.F. (1984). *Enhancing structure and management of Navy intermediate maintenance activities: Phase I. Analysis of the pump repair process* (HFOSL Technical Note 72-84-4). San Diego: Navy Personnel R & D Center.

[6] Feher, B., and Levine, M.F. (1985a). *Enhancing structure and management of Navy intermediate maintenance activities: Phase II. Implementation of changes in the pump repair system* (Technical Report 85-33). San Diego: Navy Personnel R & D Center.

[7] Feher, B., and Levine, M.F. (1985b). *Organization redesign for productivity improvement: Method and case study* (Technical Report, 86-2). San Diego: Navy Personnel R & D Center.

[8] Fiol, C.M., and Lyles, M.A. (1985). Organizational learning. *Academy of Management Review*, 10(4), 803-813.

[9] Hedberg, B. (1981) How organizations learn and unlearn. In P. Nystrom & W. Starbuck (Eds.), *Handbook of organizational design*, pp. 1-27. New York: Oxford University Press.

[10] Levine, M.F., and Feher, B. (1985). Evaluation of technostructural change in a Navy repair organization. *Proceedings, American Institute of Decision Sciences, Western Region*, 14, 161-163.

DISTRIBUTION LIST

Assistant Secretary of Defense (Force Management and Personnel)
Assistant for Training and Personnel Systems Technology (OUSD)(A)/R&T (E&LS)
Deputy Chief of Naval Operations (MP&T) (OP-01)
Assistant for MPT Research and Development and Studies (OP-01B2)
Education and Training Program Manager (OP-01B2D)
Head, Training and Education Assessment (OP-11H)
Director, Civilian Personnel Programs (OP-14)
Deputy Chief of Naval Operations (Logistics) (OP-04B)
Assistant for Manpower, Personnel, and Training (OP-987H)
Chief of Naval Education and Training (Code 00)
Chief of Naval Technical Training (Code 00) (2)
Commander, Naval Air Systems Command (NAVAIR-43Q)
Commander, Naval Sea Systems Command (SEA-07Q)
Commander, Naval Training Center, San Diego, CA
Commander, Naval Training Center, Great Lakes, IL
Commander, Naval Training Center, Orlando, FL
Commander, Training Command, U.S. Atlantic Fleet
Commander, Training Command, U.S. Atlantic Fleet (Code 01A)
Commander, Training Command, U.S. Pacific Fleet
Commander, Fleet Training Group, U.S. Atlantic Fleet
Commander, Fleet Training Group, U.S. Pacific Fleet
Commander, U.S. ARI, Behavioral and Social Sciences, Alexandria, VA (PERI-POT-I)
Commanding Officer, Fleet Aviation Specialized Operational Training Group, U.S. Atlantic Fleet
Detachment Jacksonville, Fleet Aviation Specialized Operational Training Group, U.S. Atlantic Fleet
Commanding Officer, Fleet Aviation Specialized Operational Training Group, U.S. Pacific Fleet
Commanding Officer, Fleet Combat Training Center, Pacific
Commanding Officer, Fleet Training Center, San Diego, CA
Commanding Officer, Naval Aviation Depot, North Island, CA
Commanding Officer, Naval Aviation Depot, Alameda, CA
Commanding Officer, Naval Aviation Depot, Pensacola, FL
Commanding Officer, Naval Aviation Depot, Jacksonville, FL
Commanding Officer, Naval Aviation Depot, Cherry Point, NC
Commanding Officer, Naval Aviation Depot, Norfolk, VA
Commanding Officer, Recruit Training Command, San Diego, CA (Unit 2441)
Commanding Officer, Service School Command, Naval Training Center, Orlando, FL
Commanding Officer, Service School Command, San Diego, CA
Commanding Officer, Submarine Training Facility, San Diego, CA
Commanding Officer, U.S. Coast Guard Support Center, Government Island, Alameda, CA
Education Center, Quantico, VA (MCDEC)
Director, Training Systems Development, Randolph Air Force Base, TX (Hq ATC/XPRS)
New Programs Direction Division, Office of Civilian Personnel Management (Code 42) (Code 422)
Defense Technical Information Center (DTIC) (2)